FOPR 261
Basic Geomatics for Natural Resources
Demonstration of Surveying with Total Stations

OBJECTIVE

At the end of this lab you will be familiar with the setup, calibration and operation of the **Leica Flexline TS06** Total station. This demonstration will involve:

1. Inspecting the survey equipment
2. Set up and orientate the instrument.
3. Adjusting instrument settings
4. Set a back sight azimuth
5. Measuring instrument height
6. Measuring prism height
7. Booking the measured (raw) field data
8. Calculating coordinates of measured points.

INTRODUCTION

A total Station is a multi-purpose electronic surveying instrument that combines an Electronic Distance Measurement (EDM) instrument, an electronic theodolite, and a computer in one unit. These devices automatically measure horizontal and zenith (or vertical) angles, as well as distances, and transmit the results to a built-in computer. The central processor takes all these measurements and calculates the position of a point in a coordinate system.

EQUIPMENT

- Leica Flexline TS06 total station with tripod
- Reflective prism
- Prism pole
- Steady sticks
- Hubs and axe
- Pocket tape
- Steel tape
- Calculator
- Note book with field paper and pencil

PROCEDURE

Equipment inspection – Tripod

- Begin with the tripod. Inspect all nuts, bolts and fasteners for tightness.
- Test the tripod feet for tightness
- Loosen and tighten the tripod leg clamps, checking for smooth operation.
- Slide the tripod legs up and down checking for smooth operation. Wipe any dirt from the sliding parts.
- Attach instrument to tripod legs
- Verify instrument is bolted to tripod
- Extend the tripod legs such that instrument is chin height.
- Loosen all tangent screws

Equipment inspection – Prism

- Check that prism is mounted solidly on the prism pole.
- Check the tightness of the prism holder as it mounts on the prism pole.
- Check that the tip of the prism pole where it sits on the ground is tight.

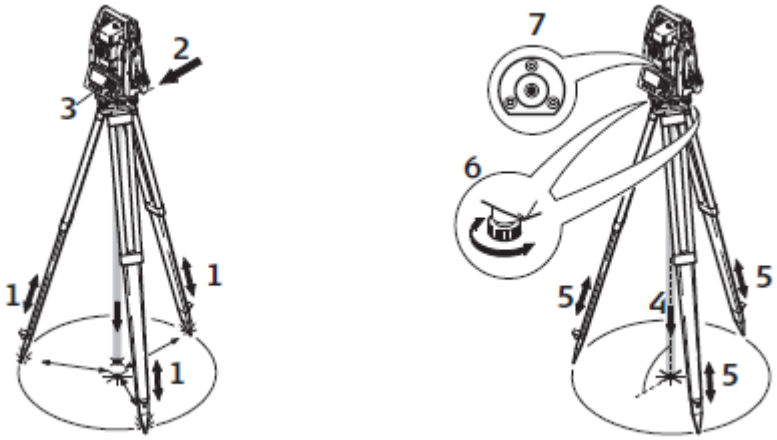
– Check the prism height adjustment mechanism for easy use. Extend the prism to its maximum height. While the prism pole is in an extended position, check that the clamping mechanism holds the prism tight without any slipping.

FIELD WORK

Setup the Total Station

– Locate the setup hub.
– Set up the instrument over a hub using the laser plummet. You will have to **TURN ON** the instrument, and the laser plummet will be activated automatically, and the **Level/Plummet** screen will appear. Otherwise, press **FNC** from within any application and select **F1** to activate the **Level/Plummet**.

Setup step-by-step



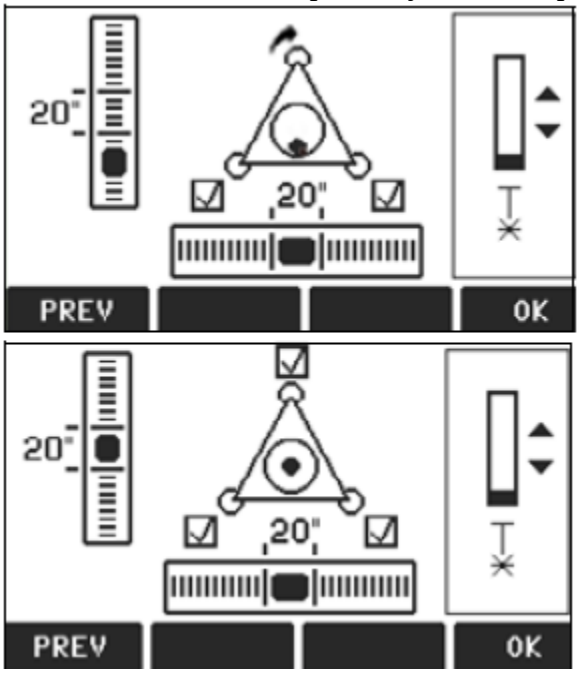
1. Extend the tripod legs to allow for a comfortable working posture. Position the tripod over the marked ground point, centring it as best as possible.
2. Fasten the tribrach and instrument onto the tripod.
3. Turn on the instrument, and, if tilt correction is set to 1- or 2-axis, the laser plummet will be activated automatically, and the **Level/Plummet** screen appears. Otherwise, press **FNC** from within any application and select **Level/Plummet**.
4. Move the tripod legs (1) and use the tribrach footscrews (6) to center the plummet (4) over the ground point.
5. Adjust the tripod legs (5) to level the circular level (7).
6. By using the electronic level, turn the tribrach footscrews (6) to precisely level the instrument. Refer to "Level up with the electronic level step-by-step".
7. Center the instrument precisely over the ground point by shifting the tribrach on the tripod plate (2).
8. Repeat steps 6. and 7. until the required accuracy is achieved.

Level up with the Electronic level Step-by-step

1. Turn the instrument until it is parallel to two footscrews.
2. Center the circular level approximately by turning the footscrews of the tribrach.
3. Turn on the instrument, and, if tilt correction is set to 1- or 2-axis, the laser plummet will be activated automatically, and the Level/Plummet screen appears. Otherwise, press FNC from within any application and select **Level/Plummet**.

- ☞ The bubble of the electronic level and the arrows for the rotating direction of the footscrews only appear if the instrument tilt is inside a certain levelling range.

4. Center the electronic level of the first axis by turning the two footscrews. Arrows show the direction of rotation required. When the electronic level is centered the arrows are replaced by checkmarks.
5. Center the electronic level for the second axis by turning the last footscrew. An arrow shows the direction of rotation required. When the electronic level is centered the arrows are replaced by checkmark.
   - ☞ When the electronic level is centered and three checkmarks are shown, the instrument has been perfectly levelled up.

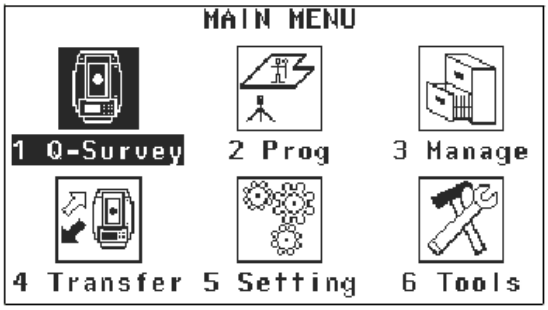


6. Accept with OK.

– Fill out your fill notes.
   a. Date
   b. Crew names
   c. Temperature
   d. Pressure
   e. Instrument make, model and number
   f. Measure the height of the instrument (**hi**) and book the value.

MAIN MENU

The MAIN MENU is the starting place for accessing all functionality of the instrument. It is usually displayed immediately after the Level/Plummet screen, after switching ON the instrument.



Description of the MAIN MENU functions

Function	Description
Q-Survey	**Quick Survey** program to begin measuring immediately. Refer to "3.5 Q-Survey Application".
Prog	To select and start applications. Refer to "9 Applications".
Manage	To manage jobs, data, codelists, formats, system memory and USB memory stick files. Refer to "10 Data Management".
Transfer	To export and import data. Refer to "10.2 Exporting Data".
Setting	To change EDM configurations, communication parameters and general instrument settings. Refer to "4 Setting".
Tools	To access instrument related tools such as check and adjust calibrations, personal start up settings, PIN code settings, licence keys and system information. Refer to "5 Tools".

Setup the Instrument Operating Parameters

Set the following instrument parameters

- EDM Mode: Prism- Standard
- Prism constant
  - Prism type: Round
  - Prism constant: 0.0 mm
- Temperature
- Pressure
- PPM correction
- Height of prism rod (**hr**)

Effects of Weather on Distance Measurement

- Distance measurement is influenced directly by the atmospheric conditions of the air in which the measurements are taken. Because the measurement system used in a total station is light based, moisture, temperature, and pressure in the light path will affect the travel of the light beam. Corrections known as atmospheric correction must be applied to the distance calculated by the total station.
- Enter Atmospheric data. Select **SETTING** from the **MAIN MENU**, Select **EDM** from the **SETTINGS MENU**, and press the **ATMOS** settings key and set the temperature and pressure settings for the day. Press **ENTER** key to store the values.
- Select **EDM MODE**: Prism-Standard, and **Prism type**: Round
- Set the prism constant to 0 mm.

- Adjust the Cross hairs for parallax.

Calibrate the prism height

- Locate a flat area of ground
- Extend the prism pole to read 1.300 meters on the prism pole graduations
- Use the measuring tape to verify the center of the prism is in fact 1.300 meters from the ground
- Write the prism pole setting and the measured value (**hr** = reflector height) in your field notes.

Setting Up the Survey Job

Select **PROGRAMS** key from the **MAIN MENU**, and Select **SURVEYING** application. All measured and recorded data is stored in JOBS, like file directories. JOBS contain measurement data, known point coordinate data (fixed points) and point codes (shot descriptors).

Select **NEW** to create a NEW job for today's data. Enter the Job name of LAB 6 followed by the operator's initials of you and your crew members. Press OK to confirm the JOB and return to Pre-Settings screen.

Setting the Station Coordinates

Once the JOB is set, the software must know where the instrument is set up. All measurements and coordinate computations are referenced to the set station coordinates. Menu item **F2, SET STATION** is used for this purpose. The station coordinates that are set must include:

- At least grid coordinates (E,N), and
- The station elevation (H), if required.

The coordinates can be entered manually or selected from memory.

When you enter a station number, a search is first made of the FIXED POINTS database and then of the MEASURED POINTS database to locate the point number and the subsequent coordinates. If the point is not found in either of these databases, you are then prompted to enter their coordinates.

To enter **Manually Station coordinates**, select **ENH** key. The coordinate screen will then appear. Then Enter the Easting (**E**), Northing (**N**), and elevation (**H**) data. If you do not know the actual UTM coordinates of the station, enter 1000.000, 1000.000, and 100.000; and press **OK**. Enter the height of the instrument from the ground surface (**hi**) once the station coordinates have been entered; and press **OK** to return to the **Pre-Settings** screen.

Setting the Orientation

Now that the instrument and software knows where it is in the coordinate system, orientation must take place. The orientation can be entered manually or determined from points that are either measured or selected from the memory.

- Select **Set Orientation** in the **Pre-settings** screen and choose: **Manual Angle Setting**. Place a second hub some distance away from the set up hub that is directly **TRUE NORTH** of the instrument.
- Place the prism over that point and hold plumb and steady with the steady sticks. Use the steady stick to level the rod bubble. Make sure the prism is pointing to the instrument.

- Aim the center of the instrument crosshairs to the center of the prism with the Gunsight. Fine-tune the instrument pointing with the horizontal and vertical tangent screws.
- Once the instrument is aligned, Press the **Hz=0** key to set the Azimuth to **000^0 00' 00"** (**Bearing = 0**), and Enter the height of the prism (**hr** = height of the reflector).
- Then press **REC** key to record the **horizontal direction only**. This will set the orientation and return to the **Pre-settings** screen.

Traversing and Data Collection

Now that you have the Job, Station, and Orientation set, you can start Traversing and data collection.

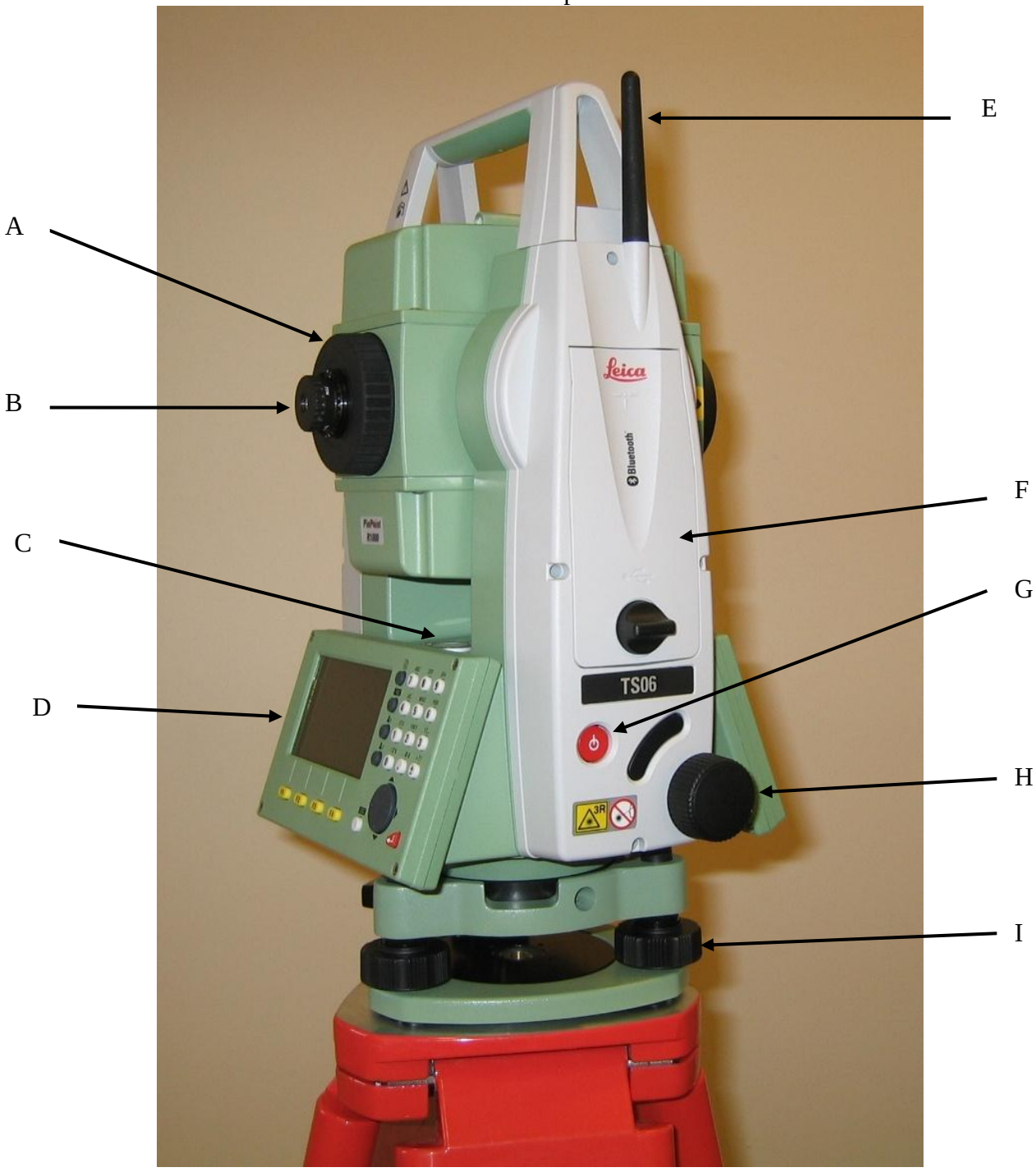
- From the **SURVEYING** menu screen, Select **4 – START.**
- This brings you to SURVEY 1/3. Remember this means the survey dialog on page 1of 3. The PtID data field will have a default alphanumeric label. Change the Starting PtID that will make sense with your grid layout. For example, start with point A1, and then shot point A2.
- You will also need to input the reflector height (**hr**). Note that the total station will keep the previous reflector height (**hr**) value for consecutive points unless you change it manually.
    - While still pointing a survey point, change the **EDM Settings** mode to reflector less (**NP= Non-Prism-Std**.) mode if necessary, for distance measurements without prisms. Press **FNC** key and select **F3 NON PRISM/PRISM TOGGLE**.
- Once you have input the **PtID** and **hr**, you can measure the slope distance and horizontal direction (Azimuth) and record the point to memory.
    - Sight the prism. Sight the vertical cross hairs at the center of the rod at its base then tilt the telescope up and sight the horizontal cross hairs to the center of the prism.
    - Press the **ALL** button to data collect the raw field data into memory and automatically calculate the coordinates of the survey point.
    - Manually record the raw field data on the total station display to your field notes
    - Now scroll to page 3/3 by pressing PAGE key. The East, North and Height coordinates should be displayed.
    - Record the rest of the grid points in the same manner. You can review the recorded points after the survey is complete from MENU → File Management.
    - Place a hub where the next instrument set up will occur.
    - Press the **ALL** button to record the raw field data into memory.
- Select **ESC** to EXIT the **SURVEY** Programs.
- Shut the instrument off, remove it from the tripod and place it in its case. Move to the traverse hub and set up.

For each new instrument set up, repeat the following procedures:

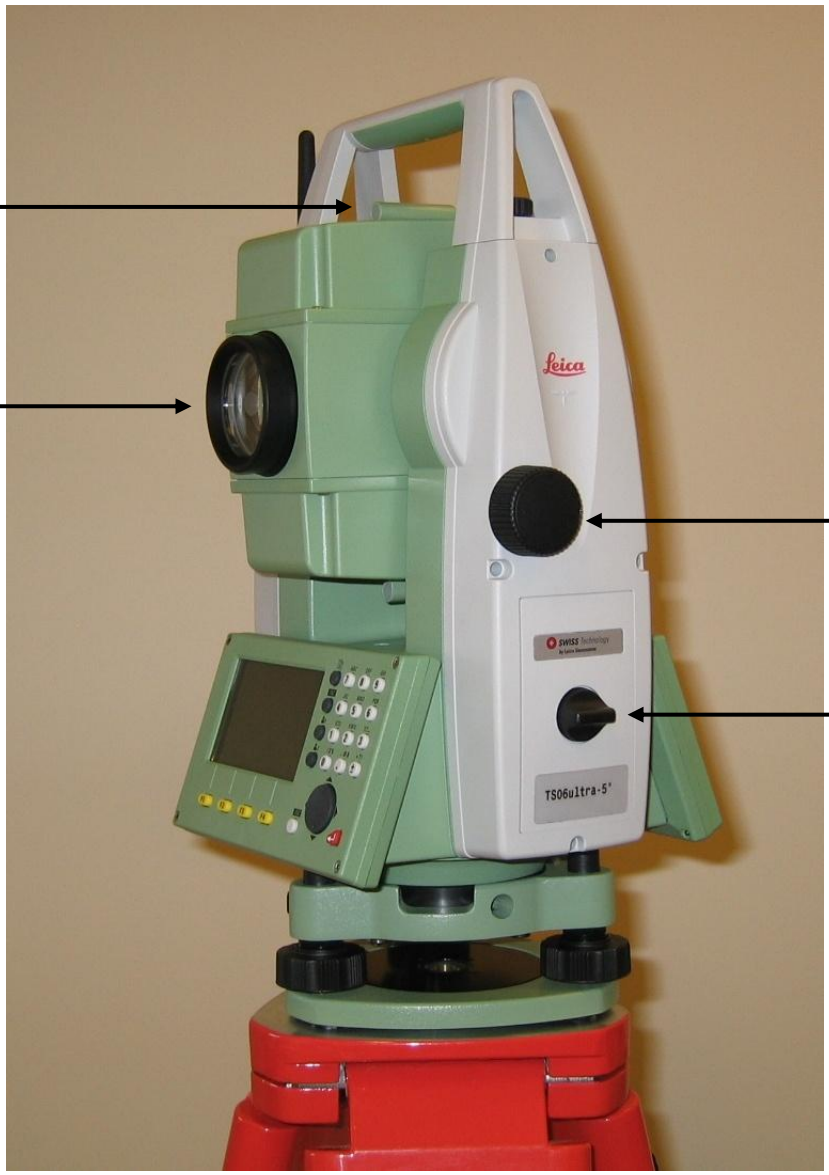
- The instrument set up procedure.
- Verification of the back sight.

- Electronic recording of the data for next traverse hub (by pressing the **ALL** button).
- Manually recording the raw field data in your field notes.

LEICA FLEXLINE TS06 TOTAL STATION
Instrument Components

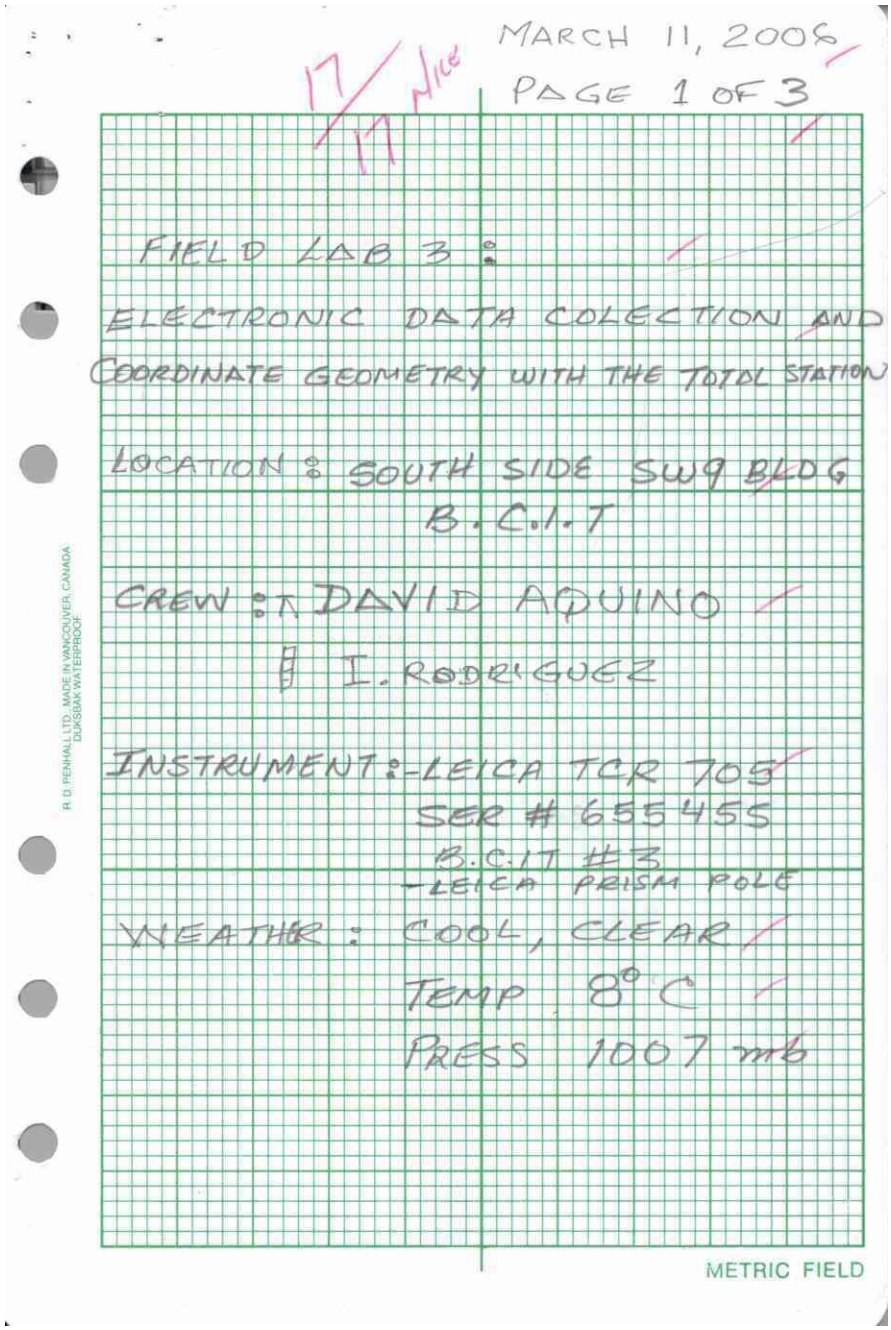


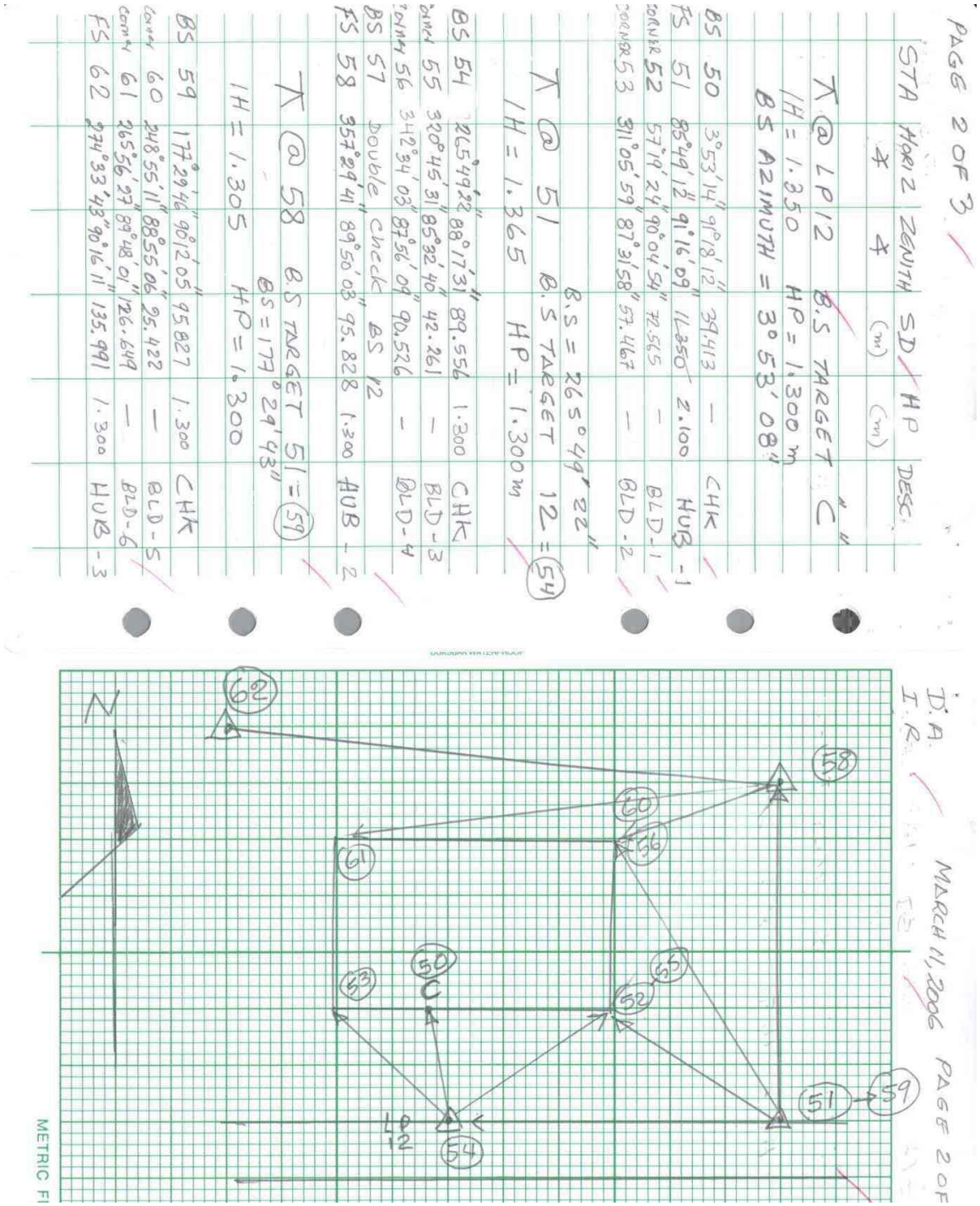
A	Objective Focus	F	Compartment for USB memory stick
B	Eyepiece	G	On/Off key
C	Bulls eye bubble	H	Horizontal Tangent Screw
D	Alphanumeric keyboard	I	Foot screw
E	Bluetooth antenna		



J	Gunsight	L	Vertical Tangent screw
K	Objective lens with integrated Electronic Distance Measurement (EDM). Exit for EDM laser beam	M	Battery cover

FIELD NOTES – EXAMPLE





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STA	HORIZ ∠	ZENITH ∠	SD (m)	HP (m)	DESC
T @ LP12			B.S TARGET C		" "
IH = 1.350			HP = 1.300 m		
BS AZIMUTH = 3°53'08"					
BS 50	3°53'14"	91°18'12"	39.413	—	CHK
FS 51	85°49'12"	91°16'09"	41.850	2.100	HUB - 1
CORNER 52	57°19'24"	90°04'54"	72.565	—	BLD-1
CORNER 53	311°05'59"	87°31'58"	57.467	—	BLD-2
	B.S = 265°49'22"				
T @ 51	B.S TARGET 12 = (54)				
IH = 1.365	HP = 1.300 m				
BS 54	265°49'22"	88°17'31"	89.556	1.300	CHK
CORNER 55	320°45'31"	85°32'40"	42.261	—	BLD-3
CORNER 56	342°34'03"	87°56'09"	90.526	—	BLD-4
BS 57	Double Check	BS 12			
FS 58	357°29'41"	89°50'03"	95.828	1.300	HUB - 2
T @ 58	B.S TARGET 51 = (59)				
	BS = 177°29'43"				
IH = 1.305	HP = 1.300				
BS 59	177°29'46"	90°20'05"	95.827	1.300	CHK
CORNER 60	248°55'11"	88°55'06"	25.422	—	BLD-5
CORNER 61	265°56'27"	89°48'01"	126.649	—	BLD-6
FS 62	274°33'43"	90°16'11"	135.991	1.300	HUB-3

D.A.
I.R.

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Lab Reference:

Leica Geosystems AG. 2008. Leica Flexline TS02/TS06/TS09 User Manual. Switzerland.